

Input to the P5 panel on DOE-HEP Accelerator Modeling Science Activities

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Expanding programmatic activities in computational accelerator science - *Importance of modeling is rising* -

Thanks to sustained advances in hardware and software technologies, computer modeling is playing an increasingly important role in all areas of science and technology, and this trend can be expected to continue for the foreseeable future. In application to the design of particle accelerators, this rise in importance is further fueled by the economic pressure for reducing uncertainties and the costs of development, construction and commissioning of accelerators, thus pushing the field toward an increase use of “virtual prototyping”, and ultimately toward code suites capable of modeling “virtual accelerators” to achieve machine optimization and design objectives at lower cost. In light of this, it is desirable to strengthen and coordinate programmatic activities of particle accelerator modeling within the HEP community [1]. This increased focus on computational activities is all the more timely as computer architectures are transitioning to new technologies that require the adaptation of existing - and emergence of new - algorithms and codes [2,3].

Distributed center of excellence for the modeling of particle accelerators – *Securing DOE leadership* -

Addressing the combined challenges of changing computer hardware and budget constraints calls for a new vision, where a national consortium of experts from various DOE laboratories coordinates and integrates the development, maintenance, distribution and support of DOE’s most widely used state-of-the-art accelerator computer codes. A world leader for advanced modeling of particle accelerators, the consortium would advance accelerator science through advanced computation, in support of the Department of Energy’s missions. Its scope would encompass the following tasks: (i) push the frontier of accelerator science through advanced simulation and modeling, and push the computing frontier in accelerator science through algorithmic advances; (ii) provide to the scientific community a comprehensive and integrated toolset of state-of-the-art simulation codes for multi-scale, multi-physics accelerator modeling, in support of the missions of the Office of Science within the Department of Energy (DOE); (iii) develop and maintain the codes on DOE’s supercomputing facilities; distribute and support codes for installation on smaller scale clusters, desktops or laptops; (iv) support users in the accelerator community for simulation and modeling of accelerator projects; (v) use the codes as educational tools to train students and young researchers on the science and the modeling of accelerators.

Through its new and unique mission in DOE Office of Science, the consortium would address several important issues that were raised in [1], most notably the poor coordination of individual modeling efforts, as well as the lack of dissemination and effective usage of accelerator modeling tools. By improving the cohesion of the existing development efforts and by ensuring that the codes are adequately disseminated and supported on DOE’s supercomputing facilities, the consortium would fulfill a central mission that would complete the DOE Office of Science portfolio in accelerator modeling activities. The collaboration would increase efficiency and free resources that would enable: (a) optimal development of more capable codes through better coordination of efforts; (b) better user support through joint workshops, web-based resources and consultation services; and (c) the design and provision of better training courses in computational accelerator physics for the accelerator community. The better capabilities and infrastructure would accelerate the pace of advances in accelerator science by enabling users to simulate complex problems involving multi-physics simulations that require the integration of modeling capabilities that currently only exist in separate packages. This would enable “virtual prototyping” of accelerator components on a larger scale than is currently possible, and ultimately lead to the modeling of “virtual accelerators or experiments”. Until now, the development of accelerator codes has been left to projects without mandate and programmatic funding for coordination, distribution and user support. While this is adequate for the development of relatively small-scale codes on targeted applications, a more coordinated approach is needed to enable general codes with user bases that extend beyond individual projects, as well as cross-cutting activities (e.g., porting codes to GPUs). Finally, the establishment of the consortium would provide a unique point-of-contact for users and enable a wider dissemination of the codes. The combined increase in code capabilities, dissemination and support would secure the Nation’s leading position in accelerator modeling, thereby significantly raising the impact – and thus the return on DOE’s investment – of computer modeling on accelerator science and technology.

- [1] “Computing Frontier: Accelerator Science”, P. Spentzouris *et al.*, DOE’s Community Summer Study Snowmass 2013; <http://arxiv.org/abs/1310.2203>
- [2] J. Shalf, J. Bashor, D. Patterson, K. Asanovic, K. Yelick, K. Keutzer and T. Mattson, “The Manycore Revolution: will HPC Lead or Follow?,” SciDAC Review (2009); <http://www.scidacreview.org/0904/html/multicore.html>
- [3] J. Cohen, C. Cantwell, N. C. Hong, D. Moxey, M. Illingworth, A. Turner, J. Darlington and S. Sherwin, “Simplifying the Development, Use and Sustainability of HPC Software,” (2013); <http://arxiv.org/pdf/1309.1101.pdf>